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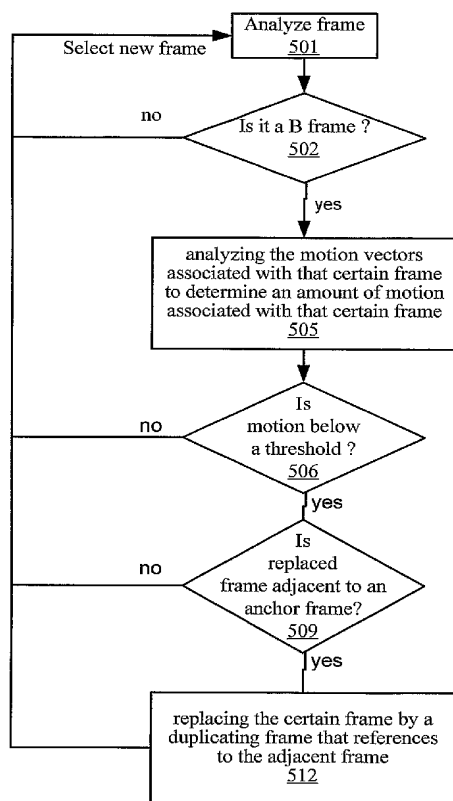
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(54) Title: VIDEO COMPRESSION DEVICE AND A METHOD FOR COMPRESSING VIDEO



(57) Abstract: A method of implementing a bit-rate reduction process for compressed digital video data, to further reduce the video bit rate requirements without adversely affecting the visual quality is described. The bit rate reduction is achieved by adaptively modifying the effective frame rate. It is affected by dropping suitable frames, or parts thereof, an replacing them with duplicating frames. The selection of frames to replace can be based on motion analysis.

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VIDEO COMPRESSION DEVICE AND A METHOD FOR COMPRESSING VIDEO

RELATED APPLICATIONS

5 This application claims the priority of U.S.
provisional patent titled "Method for further compressing
digital video", serial number 60/535671, filed January 8
2004.

10

FIELD OF THE INVENTION

 This application related to a device and method for
compressing digital video and especially for B-frame based
compression scheme.

15

BACKGROUND OF THE INVENTION

 Uncompressed video is very large. Each video image
includes a large amount of pixels and each pixel can be
20 represented by multiple bits. Various compression schemes,
such as MPEG-2 and MPEG-4 were developed in order to
reduce the cost of video storage and transmission. These
standards utilize spatial and temporal redundancy in order
to reduce the size of video streams.

25 A typical MPEG-2 video encoder receives a sequence of
frames from a video source. The sequence of frames may be
progressive or interlaced. Illustratively, the progressive
sequence includes thirty frames per second. In the case of
an interlaced sequence, each frame comprises two fields. A
30 top field comprises the even numbered rows and a bottom
field comprises the odd numbered rows. Thus, in the case
of an interlaced sequence, there are sixty fields per
second.

A typical encoder can include hardware as well as software components. U.S. patent 6760478, of Aditta et al., titled "Method and apparatus for performing two pass quality video compression through pipelining and buffer management", which is incorporated herein by reference, describes a combination of hardware and software components.

The video source may be any source of a digital video signal such as a video camera or a telecine machine. A telecine machine converts a film comprising twenty four frames per second into a sixty field per second digital video signal using 3:2 pull down. The 3:2 pull down technique provides for generating two video fields and three video fields for alternating film frames. For a film frame which is converted into three video fields, the third field is a repeat of the first field.

The video-encoder utilizes compression algorithms to generate an MPEG-2 compliant bit stream from the input sequence of frames. (See ISO/IEC 13818-2)

The MPEG-2 bit stream has six layers of syntax. There are a sequence layer (random access unit, context), Group of Pictures layer (random access unit, video coding), picture layer (primary coding layer), slice layer (resynchronization unit), macroblock (motion compensation unit) and block layer (DCT unit). A group of pictures (GOP) is a set of frames which starts with an I-frame and includes a certain number of P and B frames. The number of frames in a GOP may be fixed or may be variable. Each frame is divided into macroblocks. Illustratively, a macroblock comprises four luminance blocks and two chrominance blocks. Each block is 8x8 pixels.

U.S. patent application 20010048718 of Bruls et al., titled "Video compression" suggests to use GOPs that

include only I-frames and P-frames, thus reducing the decoding complexity. It is noted commonly used encoders use B-frames as well as P-frames and I-frames.

5 The encoder distinguishes between three kinds of frames (or pictures), I, P, and B. Typically, the coding of I frames results in the most bits. In an I-frame, each macroblock is coded as follows. Each 8x8 block of pixels in a macroblock undergoes a DCT (discrete cosine transform) transform to form an 8x8 array of transform
10 coefficients. The transform coefficients are then quantized with a variable quantizer matrix. Quantization involves dividing each DCT coefficient $F[v][u]$ by a quantizer step size. The quantizer step size for each AC DCT coefficient is determined by the product of a
15 weighting matrix element $W[v][u]$ and a quantization scale factor (also known as $mquant$). As is explained below, in some cases the quantization scale factor Q_n for a macroblock n is a product of a rate control quantization scale factor Q_n^R and a masking activity quantization scale
20 factor (QS_n). However, this factorization of the quantization scale factor Q_n is optional. The use of a quantization scale factor permits the quantization step size for each AC DCT coefficient to be modified at the cost of only a few bits. The quantization scale factor is
25 selected for each macroblock.

The resulting quantized DCT coefficients are scanned (e.g., using zig-zag scanning) to form a sequence of DCT coefficients. The DCT coefficients are then organized into run-level pairs. The run-level pairs are then encoded
30 using a variable length code (VLC). In an I-frame, each macroblock is encoded according to this technique.

In a P-frame, a decision is made to code each macroblock as an I macroblock, which macroblock is then

encoded according to the technique described above, or to code the macroblock as a P macroblock. For each P macroblock, a prediction of the macroblock in a previous video frame is obtained. The predication is identified by a motion vector which indicates the translation between the macroblock to be coded in the current frame and its prediction in the previous frame. (A variety of block matching algorithms can be used to find the particular macroblock in the previous frame which is the best match with the macroblock to be coded in the current frame. This "best match" macroblock becomes the prediction for the current macroblock.) The predictive error between the predictive macroblock and the current macroblock is then coded using the DCT, quantization, zig-zig scanning, run-level pair encoding, and VLC encoding.

In the coding of a B-frame, a decision has to be made as to the coding of each macroblock. The choices are (a) intracoding (as in an I macroblock), (b) unidirectional forward predictive coding using a previous frame to obtain a motion compensated prediction, (c) unidirectional backward predictive coding using a subsequent frame to obtain a motion compensated prediction, and (d) bidirectional predictive coding, wherein a motion compensated prediction is obtained by interpolating a backward motion compensated prediction and a forward motion compensated prediction. In the cases of forward, backward, and bidirectional motion compensated prediction, the predictive error is encoded using DCT, quantization, zig-zig scanning, run-level pair encoding and VLC encoding. U.S. patent 5818533 of Auld et al. titled "Method and apparatus for decoding B frames in video codec with minimal memory", which is incorporated herein by

reference, describes an MPEG decoder that reconstructs B frames without storing a reconstructed B frame.

5 The P frame may be predicted from an I frame or another P frame. The B frame may also be predicted from an I frame or a P frame. U.S. patent 5724446 of Liu et al., titled "Video decoder apparatus using non-reference frame as an additional prediction source and a method therefore" uses B-frames as an additional prediction source, but usually predictions are not made based upon B-frames.

10 B frames have the smallest number of bits when encoded, then P frames, with I frames having the most bits when encoded. Thus, the greatest degree of compression is achieved for B frames. For each of the I, B, and P frames, the number of bits resulting from the encoding process can
15 be controlled by controlling the quantizer step size (adaptive quantization) used to code each macroblock.

A macroblock of pixels or pixel errors which is coded using a large quantizer step size results in fewer bits than if a smaller quantizer step size is used.

20 After encoding by the video encoder, the bit stream is stored in an encoder output buffer. Then, the encoded bits are transmitted via a channel to a decoder, where the encoded bits are received in a buffer of the decoder, or the encoded bits may be stored in a storage medium.

25 The order of the frames in the encoded bit stream is the order in which the frames are decoded by the decoder. This may be different from the order in which the frames arrived at the encoder. The reason for this is that the coded bit stream contains B frames. In particular, it is
30 necessary to code the I and P frames used to anchor a B frame before coding the B frame itself.

Consider the following sequence of frames received at the input of a video encoder and the indicated coding type (I, P or B) to be used to code each frame:

5	1	2	3	4	5	6	7	8	9	10	11	12	13
	I	B	B	P	B	B	P	B	B	I	B	B	P

For this example there are two B-frames between successive coded P-frames and also two B-frames between successive coded I-and P-frames. Frames "1I" is used to form a prediction for frame "4P", and frames "1I" and "4P" are both used to form predictions for frames "2B" and "3B". Therefore, the order of coded frames in the coded sequence shall be "1I", "4P", "2B", "3B". Thus, at the encoder output, in the coded bit stream, and at the decoder input, the frames are reordered as follows:

20	1	4	2	3	7	5	6	10	8	9	13	11	12
	I	P	B	B	P	B	B	I	B	B	P	B	B

In the case of interlaced video the following applies. Each frame of interlaced video consists of two fields. The MPEG-2 specification allows the frame to be encoded as a frame picture or the two fields to be encoded as two field pictures. Frame encoding or field encoding can be adaptively selected on a frame-by-frame basis. Frame encoding is typically preferred when the video scene contains significant detail with limited motion. Field encoding, in which the second field can be predicted from the first, works better when there is fast movement.

For field prediction, predictions are made independently for the macroblocks of each field by using data from one or more previous fields (P field) or

previous and subsequent fields (B field). For frame prediction, predictions are made for the macroblocks in a frame from a previous frame (P frame) or from a previous and subsequent frame (B frame). Within a field picture, all predictions are field predictions. However, in a frame picture either field prediction or frame prediction may be selected on a macroblock by macroblock basis.

An important aspect of any video encoder is rate control. The purpose of rate control is to maximize the perceived quality of the encoded video when it is decoded at a decoder by intelligently allocating the number of bits used to encode each frame and each macroblock within a frame. Note the encoder may be a constant bit rate (CBR) encoder or a variable bit rate (VBR) encoder. In the case of constant bit rate encoder, the sequence of bit allocations to successive frames ensures that an assigned channel bit rate is maintained and that decoder buffer exceptions (overflow or underflow of decoder buffer) are avoided. In the case of a VBR encoder, the constraints are reduced. It may only be necessary to insure that a maximum channel rate is not exceeded so as to avoid decoder buffer underflow.

In order to prevent a decoder buffer exception, the encoder maintains a model of the decoder buffer. This model maintained by the encoder is known as the video buffer verifier (VBV) buffer. The VBV buffer models the decoder buffer occupancy. Depending on the VBV occupancy level, the number bits which may be budgeted for a particular frame may be increased or decreased to avoid a decoder buffer exception.

Video compression standards, like MPEG2, are specifically designed to support TV sets that traditionally display analog TV signals according to

standards like NTSC, PAL and SECAM. As such, for example, the MPEG2 standard supports both interlaced (as used by these standards) and progressive video display. Also, an important aspect of traditional analog TV sets is that they operate at fixed frame rates. Accordingly, the MPEG2 standard supports encoding at any of the commonly used fixed frame rates. The frame rate at which a television signal is drawn on a Cathode Ray Tube (CRT) is fixed by the various analog TV standards. It is a compromise between conflicting requirements.

On one hand, a higher frame rate requires higher bandwidth of the analog video signal, and the corresponding digital compressed signal used to represent it. On the other hand, a too low frame rate may yield noticeable and rejectionable flicker and jerkiness of moving objects.

Interlacing fields is a technique adopted for analog TV standards to provide a relatively high field refresh rate (typically 50 or 60 Hz) and still conserve the required bandwidth, by displaying alternately the odd and even lines of the frame. Since the whole picture is repeatedly redrawn on phosphor that illuminates for a very short time, flicker will occur if the refresh rate is low enough to be detected by the human eye.

High illumination levels of ambient light or of the displayed image requires a higher refresh rate to still be unnoticed. 50-60 Hz have been determined to yield a reasonably flicker free image on modern TV sets. Even so, 100Hz TV sets multiply the frame rate to reduce the flicker even further. Another reason to have a relatively high refresh rate is to avoid jerkiness associated with fast moving objects. Even though the images are reconstructed as discrete images in time, if they are

repeated at a high enough rate the human eye will perceive them as smooth continuous motion. The frame refresh rate to provide smooth video is found to be at least 24 Hz, as in cinema movies. In cinema movies, the common picture
5 refresh rate is 24 Hz, however every frame is repeated to prevent flicker of being noticeable.

The rate at which pictures need to be displayed to prevent jerkiness is a function of the amount of motion in the pictures. The more motion exists, the higher the
10 required refresh rate. It follows that the refresh rate required to avoid flicker and the refresh rate required to avoid jerkiness are independent, the former is more or less fixed and independent of video content, while the later depends on the amount of motion in the video.

15 Various methods and devices were designed for compressing video streams.

U.S. Pat. No. 5,956,088 mentions dropping B-frames, fully or partially, as a means to reduce the required bit rate to represent a video stream. However, simply dropping
20 B-frames adversely affects the resulting visual quality of the decoded stream as it may cause jerkiness of motion.

There is a need to provide an efficient method and device for compressing video, especially without a noticeable visual degradation of the compressed video.

25

SUMMARY OF THE INVENTION

A method for compressing a group of frames, the method includes: (i) receiving a group of frames that includes at least one non-reference frame; and (ii)
30 replacing at least one non-reference frame by a duplicating frame; wherein the duplicating frame includes information representative of an instruction to duplicate another frame.

A method for compressing a group of frames, the method includes: (i) receiving a group of frames that includes at least one non-reference frame; and (ii) determining whether to replace a portion of a non-reference frame by a duplicating frame portion; wherein the duplicating frame portion includes information representative of an instruction to duplicate another frame portion.

Conveniently, a determination to replace a frame of a portion of a frame is followed by a replacement of the frame or frame portion.

A computer readable medium having code embodied therein for causing an electronic device to perform the stages of: receiving a group of frames that includes at least one non-reference frame; and replacing at least one non-reference frame by a duplicating frame; wherein the duplicating frame includes information representative of an instruction to duplicate another frame.

A computer readable medium having code embodied therein for causing an electronic device to perform the stages of: receiving a group of frames that includes at least one non-reference frame; and determining whether to replace a portion of a non-reference frame by a duplicating frame portion; wherein the duplicating frame portion includes information representative of an instruction to duplicate another frame portion.

A video compression device that is adapted to receive a group of frames that includes at least one non-reference frame. The device includes a unit adapted to replace at least one non-reference frame by a duplicating frame and the duplicating frame includes information representative of an instruction to duplicate another frame.

Conveniently, the device includes a unit adapted to provide information representative of motion associated with a certain non-reference frame. Conveniently, the device is adapted to perform a replacement in response to
5 an amount of motion associated with the replaced non-reference frame. Conveniently, the replacement is responsive to a motion threshold. Conveniently, the replacement is responsive to an absolute sum of motion vectors included within the non-reference frame.

10 Conveniently, the replacement is responsive to a required compression ratio.

Conveniently, the device is further adapted to compress at least one frame by an operation that differs from the replacing. Conveniently, this operation involves
15 re-quantizing.

Conveniently, the non-reference frame is a B frame. Conveniently, the other frame is an anchor frame.

Conveniently, the device is further adapted to analyze the replaced non-reference frame to determine an
20 amount of motion associated with the certain non-reference. Conveniently, the device is adapted to retrieve an amount of motion associated with the certain non-reference.

Conveniently, the replacement is responsive to the
25 limitations of the device, such as but not limited to a storage limitation and/or a processing limitation.

A video compression device, the device being adapted to receive a group of frames that includes at least one non-reference frame. Wherein the device includes a unit
30 adapted to determine whether to replace a portion of a non-reference frame by a duplicating frame portion. And the duplicating frame portion includes information

representative of an instruction to duplicate another frame portion.

Conveniently the device includes a unit that is adapted to provide information representative of motion
5 associated with a certain non-reference frame portion.

Conveniently, the device is further adapted to replace the frame portion. Conveniently, the replacement is responsive to an amount of motion associated with the replaced non-reference frame portion. Conveniently, the
10 determination is responsive to a motion threshold. Conveniently, the determination is responsive to a required compression ratio.

Conveniently, the device is further adapted to compress at least one frame portion by an operation that
15 differs from the replacing. Conveniently, this operation involves re-quantization.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood and
20 appreciated more fully from the following detailed description taken in conjunction with the drawings in which:

Figure 1 illustrates a device for compressing video frames, according to an embodiment of the invention;

25 Figure 2 illustrates a device for compressing video frames according to another embodiment of the invention;

Figure 3 illustrates a group of frames;

Figure 4 illustrates a frame and multiple replaced macroblocks, according to embodiment of the invention; and

30 Figures 5 - 7 are flow charts of methods for compressing video according to various embodiments of the invention.

DETAILED DESCRIPTION OF THE DRAWINGS

The invention allows to compress video and especially a group of video frames by selectively replacing non-reference frames by duplicating frames. Non-reference
5 frames are frames that are not used as a reference during a decoding process of other frames. In other words the decoding or construction process of other frames is not dependent upon the content of the non-reference frames.

For convenience of explanation the following
10 description related to MPEG-2 compliant frames. And especially to B frames. It is noted that the invention can be applied mutatis mutandis to video that is compressed in other manners.

It is noted that the replacement of frames by
15 duplicating frames can be applied in various scenarios, by different devices. For example, this can be applied in the context of an encoder operating on bitmaps, or it can be employed by a transrater that is adapted to alter the bit rate of a pre-encoded video stream

20 Figure 1 illustrates a device 100 for compressing video frames, according to an embodiment of the invention. Device 100 can include hardware, software, middleware or a combination of at least one of said elements.

Device 100 includes a motion estimation block 101
25 that is followed by a decision unit 102 that can optionally also be capable of replacing frames or frame portions in response to the determination. The motion estimation unit 101 is capable of generating B frames and P frames and especially is capable of generating motion
30 vectors. It is noted that the motion estimation block can be adapted to perform motion estimation without completing the process of generating such frames.

After motion estimation unit 101 generates motion vectors, such as optimal motion vectors, it utilizes these motion vectors to determine an amount of motion associated with each frame.

5 The frames as well as information representative of the amount of motion is sent to the decision unit 102 that in turn decides whether to replace one or more non-reference frames. It is further noted that the amount of motion can be determined by the decision unit 102.

10 According to an embodiment of the invention the amount of motion associated with a frame is compared to a predefined threshold. It is noted that this threshold can be altered, for example in response to a required compression ratio.

15 Conveniently, the threshold is compared to the absolute sum of the motion vectors of a certain non-reference frame.

Figure 2 illustrates a device 200 for compressing video frames according to another embodiment of the invention. Device 200 differs from device 100 of figure 1 by retrieving motion vectors instead of generating said vectors.

Device 200 includes a parse motion vector unit 201 that is followed by a decision unit 202. The parse motion vector unit 201 retrieves motion vectors or other representation of motion from an input stream. Thus, device 200 retrieves previously generated motion vector instead of generating motion vectors, like device 100.

Parse motion vector unit 201 decodes motion vectors from a compressed bit stream to provide an estimate on the amount of motion inherent in the given frame. Unit 202 can apply the same kind of decision mechanism as device 102 of

figure 1 to determine if a non-reference frame can be replaced by a duplicating frame.

According to various embodiments of the invention a decision to replace a certain non-reference frame can be responsive to a characteristic of the frame itself or to other parameters such as computational load, replacing device limitations (including storage or computational limitations). Thus, the decision whether to replace a certain non-reference frame can be dependent upon other frames.

Conveniently, only non-reference frames can be replaced by duplicating frames. Their replacement does not introduce additional error to other frames.

According to an embodiment of the invention the duplicating frames include information that instructs a decoder to replace a certain frame by an anchor frame, and especially by an adjacent anchor frame.

According to other embodiments of the invention the decision unit 202 (or 102) is adapted to receive information representative of limitations of device 200 (or 100) and in response determine whether to replace one or more non-reference frames. It is noted that the decision can also be responsive to information provided by optional unit 201 (or 101). For example, the inventors used a device that includes an input FIFO and an output FIFO. When the device was not capable to process frames in an adequate rate the input FIFO is gradually filled and can even overflow. Thus, by tracking the emptiness of the input FIFO the device can determine when a replacement is required and even the required compression ratio.

Figure 3 illustrates a group 301 of frames, including reference frames (also referred to as anchor frames) and non-reference frames such as B frames.

The group 301 includes a I frame (I1) that is followed by two B frames (B2 and B3), that are followed by a P frame (P4) that in turn is followed by a pair of B frames (B6 and B7).

5 The arrows associate between B frames and anchor frames that can be referred to by duplicating frames that replace these B frames.

 Since replacement frames such as zero unidirectional B-frames effectively duplicate the referenced anchor
10 frame, they should reference adjacent anchor frames. In FIG. 3, the B2 frame could be replaced with an duplicating frame that references the past I1 frame (effectively duplicating it), and the B3 frame could be replaced with an empty B-frame that references the future P4 frame.

15 Replacing prediction frames by empty unidirectional prediction frames (also referred to as duplicating frames) which are frames that include a zero prediction error referenced to either a past or future anchor frame, in effect causes a duplication of the anchor (reference)
20 frame. Since zero error prediction frames are extremely small, they also yield a reduction in the required bit rate.

 According to an embodiment of the invention the selective frame replacement action is the only bit rate
25 reduction operation. According to another embodiment of the invention the compression process also includes additional compression operations, like DCT coefficient re-quantization.

 According to an embodiment of the invention the
30 replacement is done on a frame basis but this is not necessarily so. According to various embodiments of the invention the replacement can be done on a frame-portion basis.

Figure 4 illustrates a frame 400 that includes various macroblocks that are associated with different amounts of motion.

Frame 400 includes macroblocks (collectively denoted 5 402) that are include significant motion and are therefore not suitable candidates for replacement, and macroblock, such as isolated macroblocks 401 or contiguous clusters of macroblocks 403, which contain little motion. Empty unidirectional prediction error macroblocks can be 10 substituted just for those macroblocks.

Figure 5 is a flow chart of method 500 for compressing video according to an embodiment of the invention.

Method 500 starts by stages 501 and 502 of analyzing 15 a certain frame to determine if it is a non-reference frame such as a B frame or not. If the answer is negative stage 502 is followed by stage 501 that is applied on the next frame. Else, stage 502 is followed by stage 505 of analyzing the motion vectors associated with that certain 20 frame to determine an amount of motion associated with that certain frame. The amount of motion (also referred to as motion activity factor) is computed based on the motion vectors of that certain frame. For example, the sum of absolute vector sizes can be used.

25 The amount of motion is then compared, during stage 506, to a threshold and if it is below the threshold stage then stage 506 is followed by stage 509 of checking if the certain frame is adjacent an anchor frame. If the answer is positive stage 509 is followed by stage 512 replacing 30 the certain frame by a duplicating frame that references to the adjacent frame.

Stages 506 is followed by stage 501 of analyzing a next frame if the motion is above the threshold. Stage 509

is followed by stage 501 if the adjacent frames are not anchor frames. Stage 512 is followed by stage 501.

It is noted that the process 500 can end once whole frame group is processed but this is not necessarily so.

5 The duplicating frame is conveniently an empty B-frame that references the adjacent anchor frame. The duplicating frame is very small, as it encodes a zero prediction error frame with zero vectors, effectively duplicating the anchor frame.

10 Figure 6 is a flow chart of method 600 for compressing a group of frames. Method 600 starts by stage 610 of receiving a group of frames that includes at least one non-reference frame. Stage 610 is followed by stage 620 of replacing at least one non-reference frame by a
15 duplicating frame; wherein the duplicating frame includes information representative of an instruction to duplicate another frame.

Conveniently, stage 620 of replacing is responsive to an amount of motion associated with the replaced non-
20 reference frame. Conveniently, the determining whether to replace a non-reference frame is responsive to a motion threshold. According to an embodiment of the invention the determining is responsive to an absolute sum of motion vectors included within the non-reference frame.

25 According to another embodiment of the invention the determining is responsive to a required compression ratio. Conveniently, method 600 further includes compressing at least one frame by an operation that differs from the replacing. This operation can be a re-quantization
30 operation.

Conveniently, the non-reference frame is a B frame. Conveniently, the adjacent frame is an anchor frame.

According to various embodiments of the invention the replacing is preceded by analyzing the replaced non-reference frame to determine an amount of motion associated with the certain non-reference. The replacing
5 can alternatively be preceded by retrieving an amount of motion associated with the certain non-reference.

Conveniently, the replacing is responsive to limitations of a replacing device, such as computational limitations and/or storage limitations.

10 According to an embodiment of the invention the duplicating frame references an adjacent frame.

Figure 7 is a flow chart of method 700 for compressing a group of frames. Method 700 starts by stage 710 of receiving a group of frames that includes at least
15 one non-reference frame. Stage 710 is followed by stage 720 of determining whether to replace a portion of a non-reference frame by a duplicating frame portion; wherein the duplicating frame portion includes information representative of an instruction to duplicate another
20 frame portion. Stage 720 is followed by stage 730 of replacing said frames in response to the determination.

According to an embodiment of the invention the video compression process does not result in a noticeable visual degradation of the compressed video. By replacing non-
25 reference that are associated with a low motion.

According to an embodiment of the invention an amount of bit rate reduction required to achieve a target bit rate could affect the threshold. For example, the threshold can be proportional to the compression ratio.

30 According to an embodiment of the invention the motion associated with a frame can be estimated in various manners. For example, said motion can be determined in

response to an amount of motion vectors beyond a certain threshold considered to be significant.

Variations, modifications, and other implementations of what is described herein will occur to those of
5 ordinary skill in the art without departing from the spirit and the scope of the invention as claimed.
Accordingly, the invention is to be defined not by the preceding illustrative description but instead by the spirit and scope of the following claims.

10

WE CLAIM

1. A method for compressing a group of frames, the method comprises:

5 receiving a group of frames that comprises at least one non-reference frame; and

replacing at least one non-reference frame by a duplicating frame; wherein the duplicating frame includes information representative of an instruction to duplicate
10 another frame.

2. The method of claim 1 wherein the replacing is responsive to an amount of motion associated with the replaced non-reference frame.

3. The method of claim 2 wherein the replacing is
15 responsive to a motion threshold.

4. The method of claim 2 wherein the replacing is responsive to an absolute sum of motion vectors included within the non-reference frame.

5. The method of claim 2 wherein the replacing is
20 responsive to a required compression ratio.

6. The method of claim 1 further comprising compressing at least one frame by an operation that differs from the replacing.

7. The method of claim 6 wherein the operation involves
25 re-quantizing.

8. The method of claim 1 wherein the non-reference frame is a B frame.

9. The method of claim 1 wherein the other frame is an anchor frame.

30 10. The method of claim 1 wherein the replacing is preceded by analyzing the replaced non-reference frame to determine an amount of motion associated with the certain non-reference.

11. The method of claim 1 wherein the replacing is preceded by retrieving an amount of motion associated with the certain non-reference.
12. The method of claim 1 wherein the replacing is responsive to limitations of a replacing device.
13. The method of claim 1 wherein the limitations comprise computational limitations.
14. The method of claim 1 wherein the limitations comprise storage limitations.
15. The method of claim 1 wherein the other frame is an adjacent frame.
16. A method for compressing a group of frames, the method comprises:
- receiving a group of frames that comprises at least one non-reference frame; and
 - determining whether to replace a portion of a non-reference frame by a duplicating frame portion; wherein the duplicating frame portion includes information representative of an instruction to duplicate another frame portion.
17. The method of claim 16 further comprising replacing the frame portion.
18. The method of claim 17 wherein the replacing is responsive to an amount of motion associated with the replaced non-reference frame portion.
19. The method of claim 16 wherein the determining is responsive to a motion threshold.
20. The method of claim 16 wherein the determining is responsive to a required compression ratio.
21. The method of claim 16 further comprising compressing at least one frame portion by an operation that differs from the replacing.

22. The method of claim 21 wherein the operation involves re-quantizing.

23. A video compression device, the device is adapted to receive a group of frames that comprises at least one non-reference frame;

wherein the device comprises a unit adapted to replace at least one non-reference frame by a duplicating frame;

wherein the duplicating frame includes information representative of an instruction to duplicate another frame.

24. The device of claim 23 wherein the device comprises a unit adapted to provide information representative of motion associated with a certain non-reference frame.

25. The device of claim 23 adapted to perform a replacement in response to an amount of motion associated with the replaced non-reference frame.

26. The device of claim 25 wherein the replacement is responsive to a motion threshold.

27. The device of claim 25 wherein the replacement is responsive to an absolute sum of motion vectors included within the non-reference frame.

28. The device of claim 23 wherein the replacement is responsive to a required compression ratio.

29. The device of claim 23 further adapted to compress at least one frame by an operation that differs from the replacing.

30. The device of claim 29 wherein the operation involves re-quantizing.

31. The device of claim 23 wherein the non-reference frame is a B frame.

32. The device of claim 23 wherein the other frame is an anchor frame.

33. The device of claim 23 wherein the device is further adapted to analyze the replaced non-reference frame to determine an amount of motion associated with the certain non-reference.

5 34. The device of claim 23 wherein the replacement is adapted to retrieve an amount of motion associated with the certain non-reference.

35. The device of claim 23 whereas the replacement is responsive to the limitations of the device.

10 36. A video compression device, the device being adapted to receive a group of frames that comprises at least one non-reference frame; and

wherein the device comprises a unit adapted to determine whether to replace a portion of a non-reference frame by a duplicating frame portion;

15 wherein the duplicating frame portion includes information representative of an instruction to duplicate another frame portion.

37. The device of claim 36 comprises a unit adapted to provide information representative of motion associated with a certain non-reference frame portion.

38. The device of claim 36 further adapted to replace the frame portion.

39. The device of claim 36 wherein the replacement is responsive to an amount of motion associated with the replaced non-reference frame portion.

40. The device of claim 36 wherein the determination is responsive to a motion threshold.

41. The device of claim 36 wherein the determination is responsive to a required compression ratio.

42. The device of claim 36 further adapted to compress at least one frame portion by an operation that differs from the replacing.

43. The device of claim 42 wherein the operation involves re-quantization.

44. A computer readable medium having code embodied therein for causing an electronic device to perform the
5 stages of:

receiving a group of frames that comprises at least one non-reference frame; and

replacing at least one non-reference frame by a duplicating frame; wherein the duplicating frame includes
10 information representative of an instruction to duplicate another frame.

45. A computer readable medium having code embodied therein for causing an electronic device to perform the stages of:

15 receiving a group of frames that comprises at least one non-reference frame; and

determining whether to replace a portion of a non-reference frame by a duplicating frame portion;

wherein the duplicating frame portion includes
20 information representative of an instruction to duplicate another frame portion.

25

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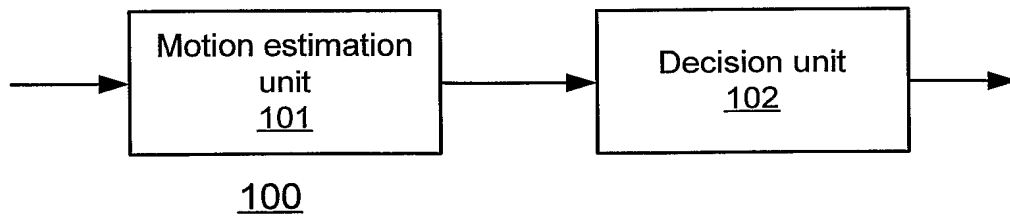


FIGURE 1

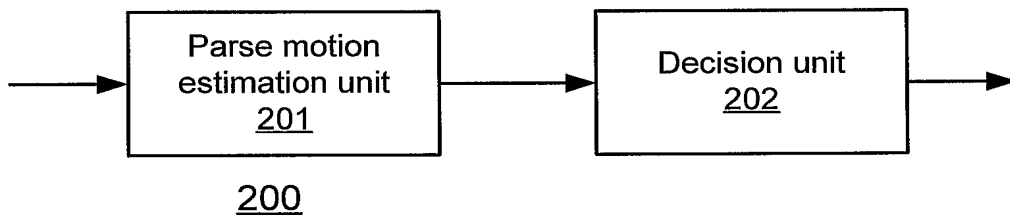


FIGURE 2

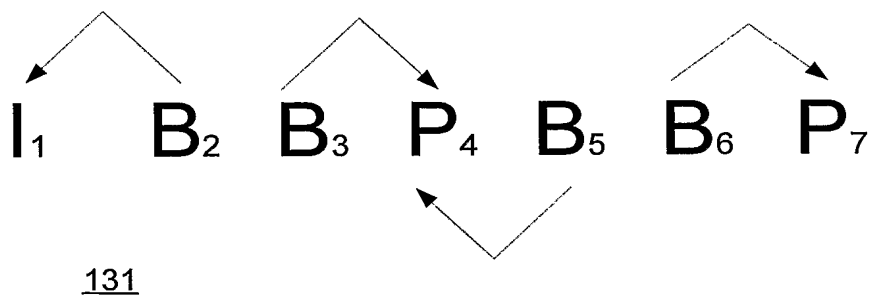


FIGURE 3

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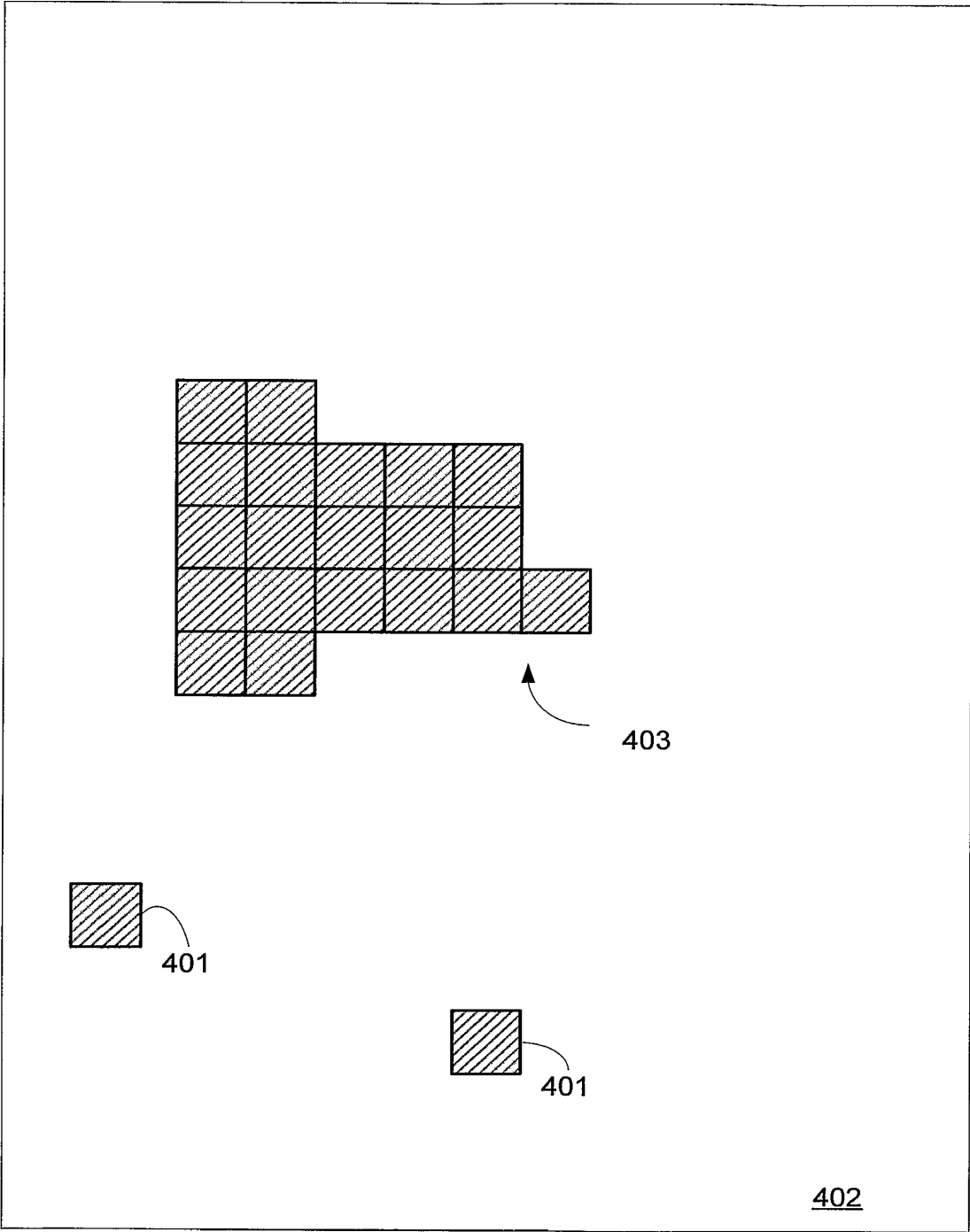
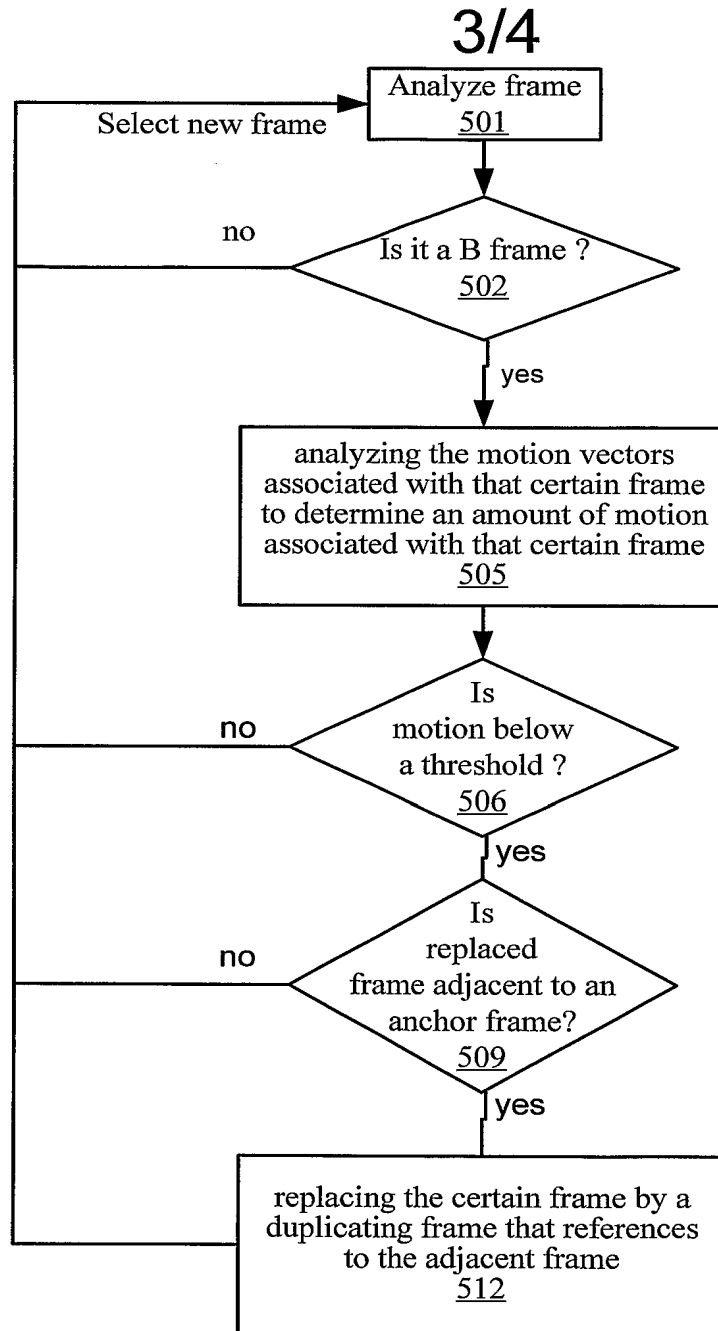


FIGURE 4

500**FIGURE 5**

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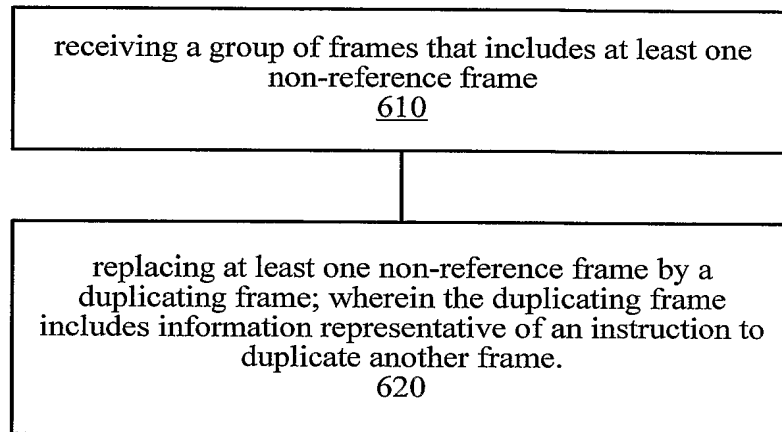
600

FIGURE 6

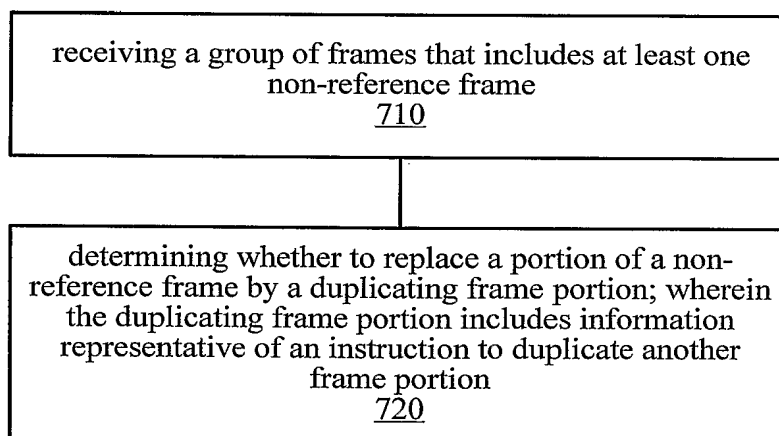
700

FIGURE 7